CCS Technical Documentation
RH-34 Series Transceivers

Troubleshooting - RF (Part 1)

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RF Troubleshooting

The RH-34 is based on Apollo Engine with dual band, tri-mode operation. The handsets are based on GSM Wolfgang/Jacqueline mechanics with a common engine.

RH-34 features 1900MHz PCS CDMA, 800MHz Cell CDMA and AMPS, an internal antenna, GPS, FM radio, RUIM card, and a color LCD.

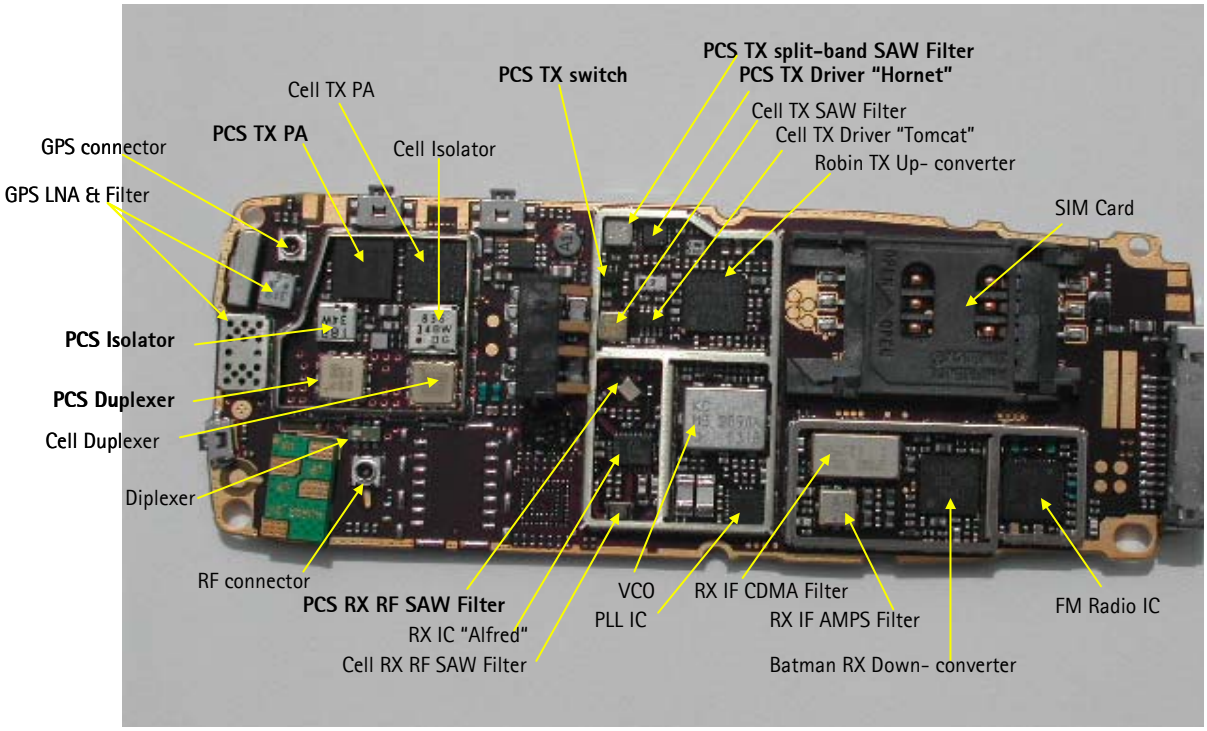

Figure 1: RH-34 RF components

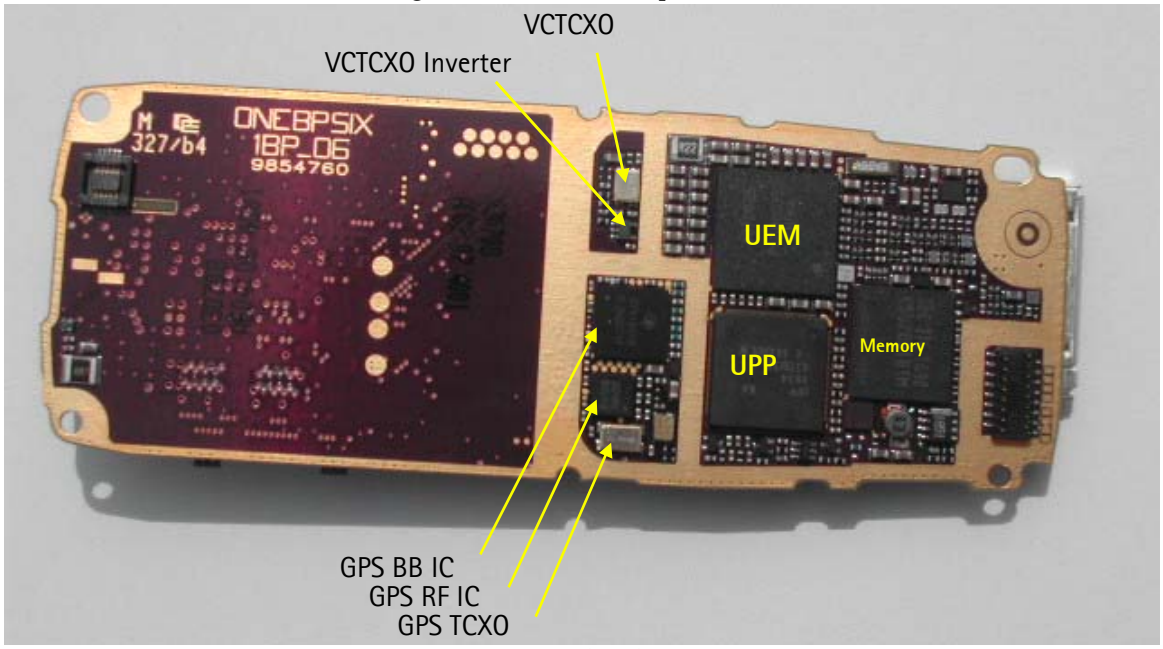

Figure 2: RH-34 Baseband components

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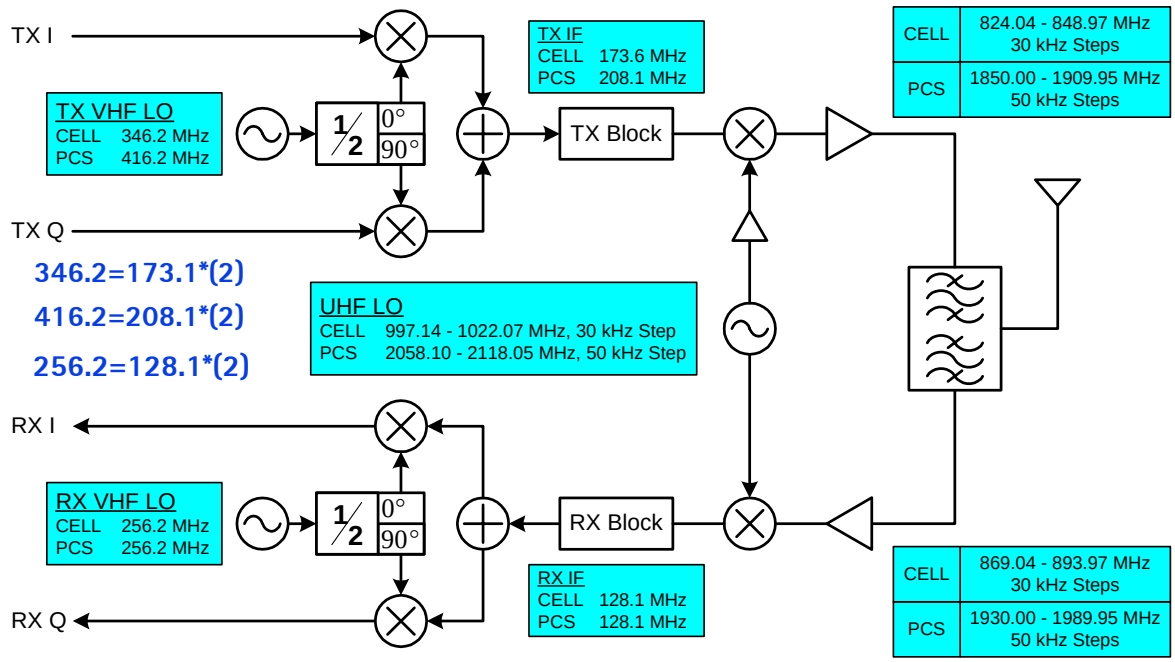
Equipment List for RF Troubleshooting

- Computer with Phoenix
- Agilent 8960 CDMA call box

Note: (If 8960 is not available, then a Signal Generator is needed.

- Power Supply
- Diagnostic Test Jig
- RF connector snap cable
- Spectrum Analyzer
- Active FET Probe
- Tomahawk Headset and Universal Headset for FM radio



Phoenix Service Software

In the RF environment, Phoenix SW provides 10 components for troubleshooting:

Phone Control in DSP
RF Main Mode in RF
CDMA Control in DSP
RF PDM in RF
Gen I/O in RF
RF Register R/W in RF
UHF Synthesizer in RF
Batch Tune in RF

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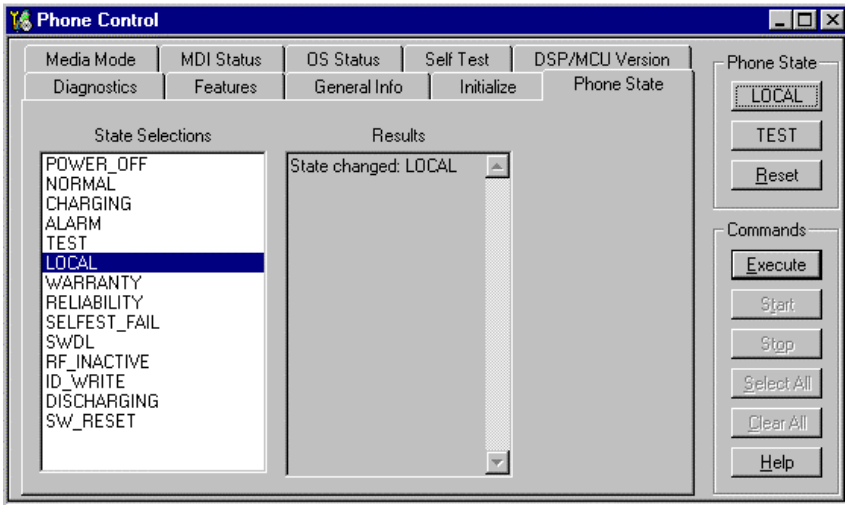
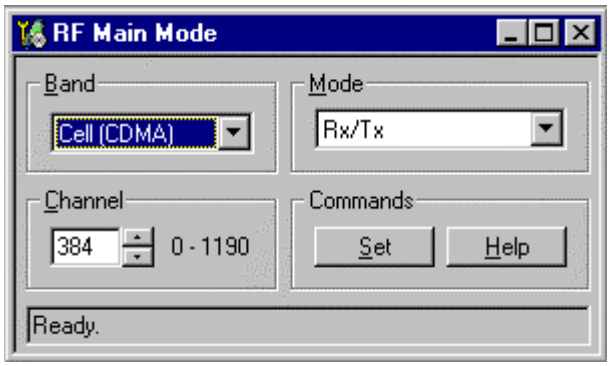
RF Tuning in RF
RF AGC Status in RF

RF (Manual Control) Components in Phoenix

① Phone Control in DSP



② RF Main Mode in RF



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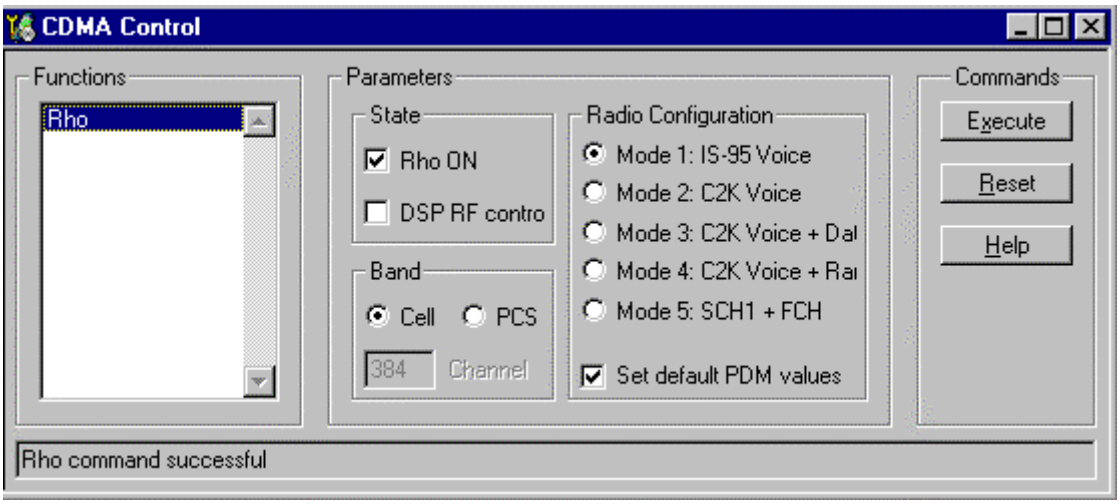
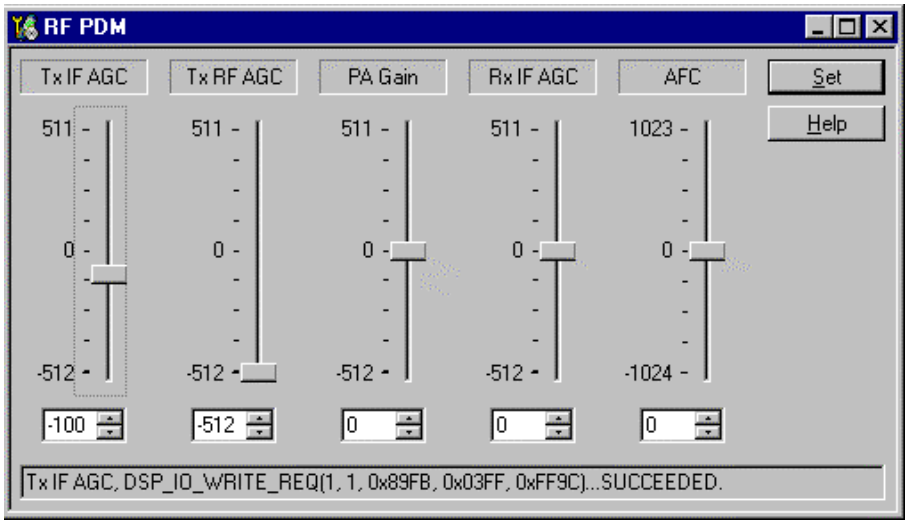
③ CDMA Control in DSP



④ RF PDM in RF



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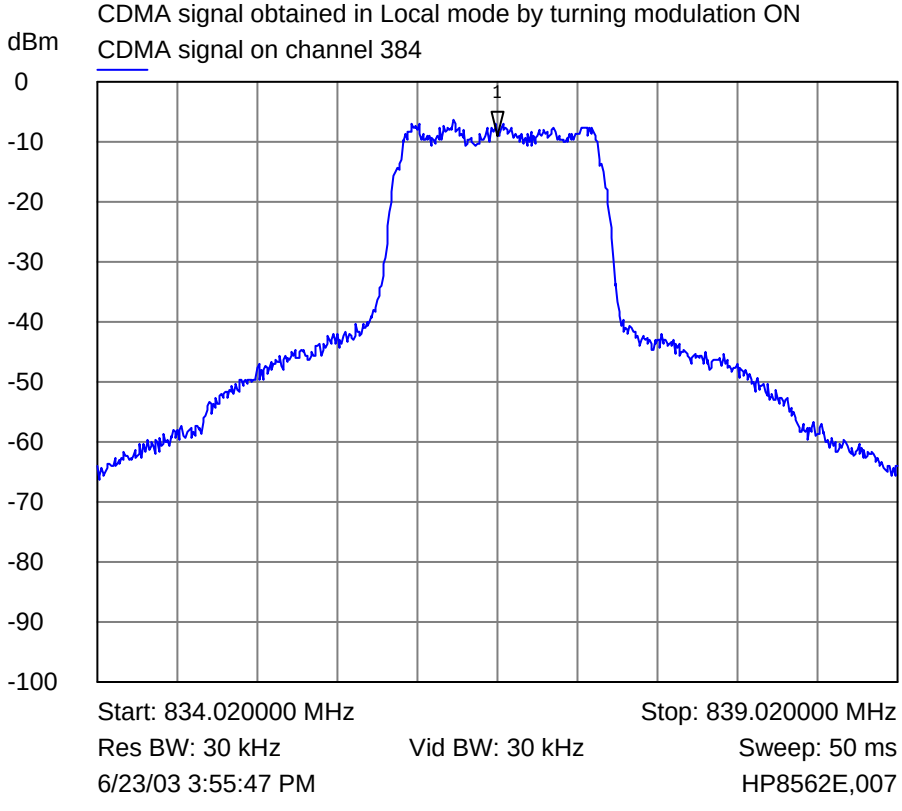
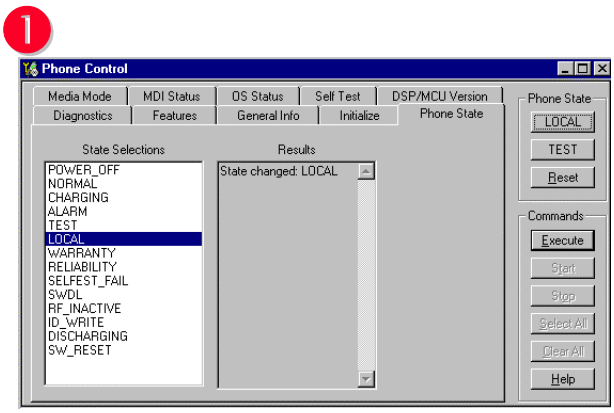
Observing Tx Output Spectrum on Analyzer

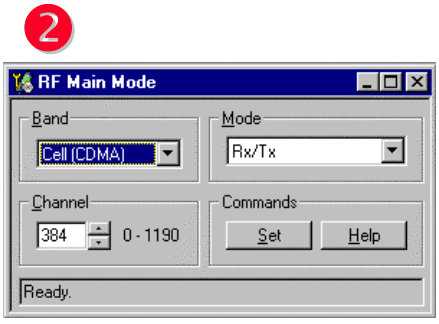
CDMA signal obtained in Local mode by turning modulation ON



Using a spectrum analyzer to observe Tx waveform:

- Enable Local Mode (test jig can be set to Local)
- Select CDMA and Rx/Tx Mode (Tx path enabled)
- Select Rho ON on CDMA Control and Execute
- Adjust the 3 Tx AGC for proper output power level





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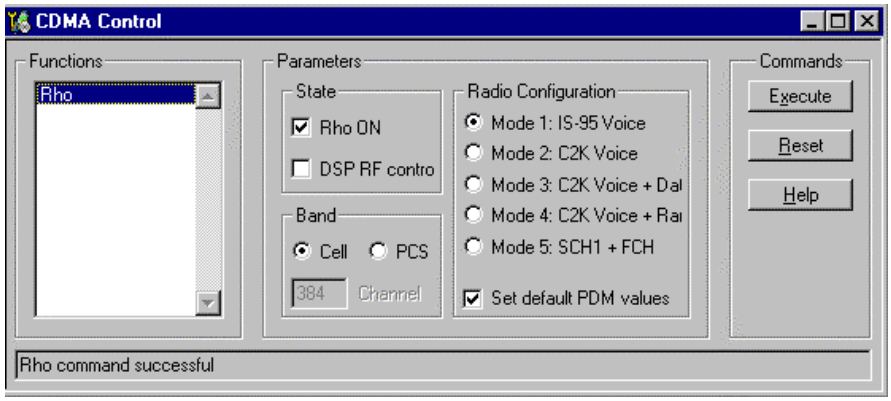

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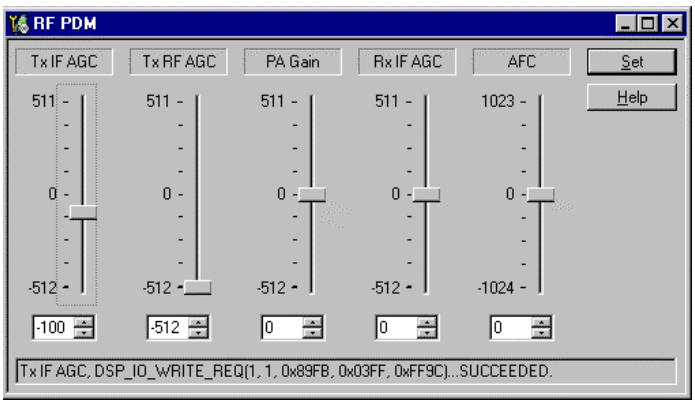

RF PDM Settings

Automatic Frequency Control (AFC):
Control range from -1024 to +1023. Used as a control line to tune the VCTCXO. Monitor the change in frequency of the VCTCXO as the AFC is changed. Use in Local Mode only.

Automatic Gain Control for Transmitter (Tx AGC):
Consists of the Tx IF AGC, the Tx RF AGC, and the PA AGC. Used as control lines to adjust the transmitter output levels. Monitor the Tx power with call box or analyzer. Local Mode only.

Automatic Gain Control for Receiver (Rx AGC):
Consists of the Rx IF AGC. Used as control line to adjust the receiver input level. Local Mode use only.

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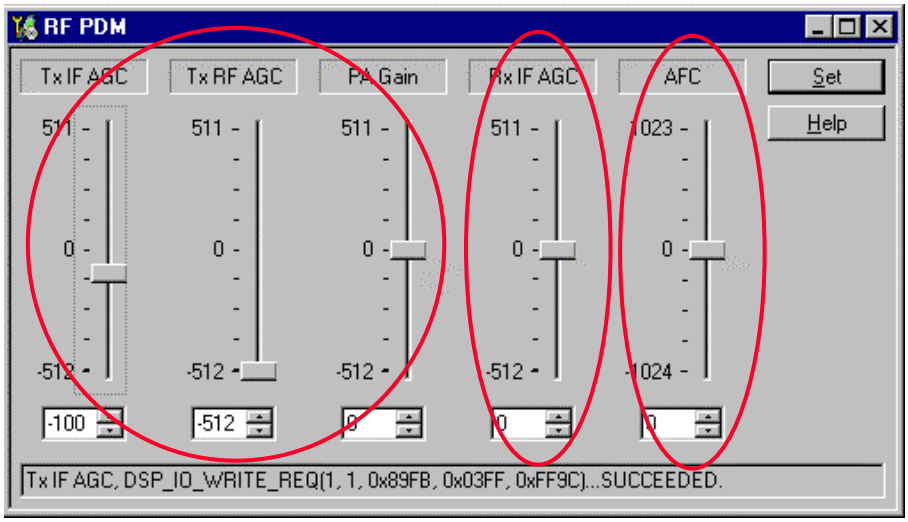

Note:
This RF PDM component only works in Local Mode.

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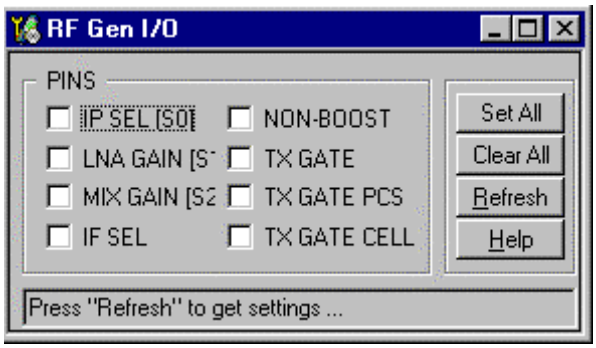
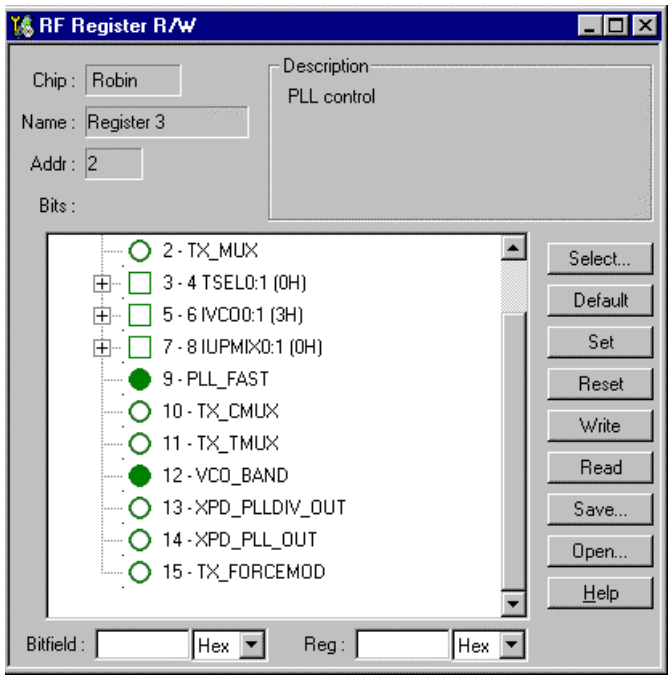
Other RF Parameters in Phoenix

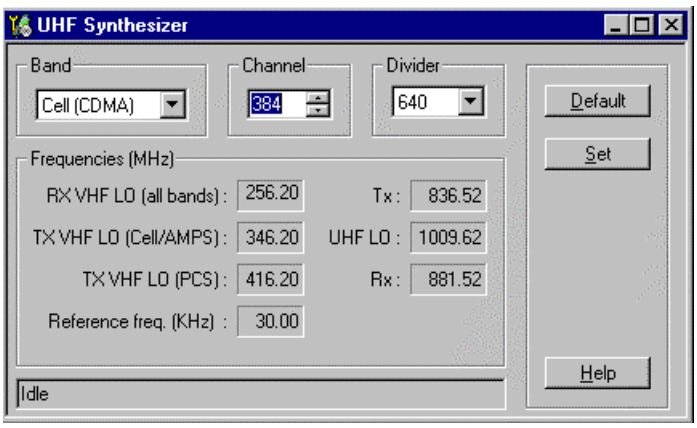
⑤ Gen I/O in RF



⑥ RF register Read/Write in RF



⑦ Frequency Calculator in RF



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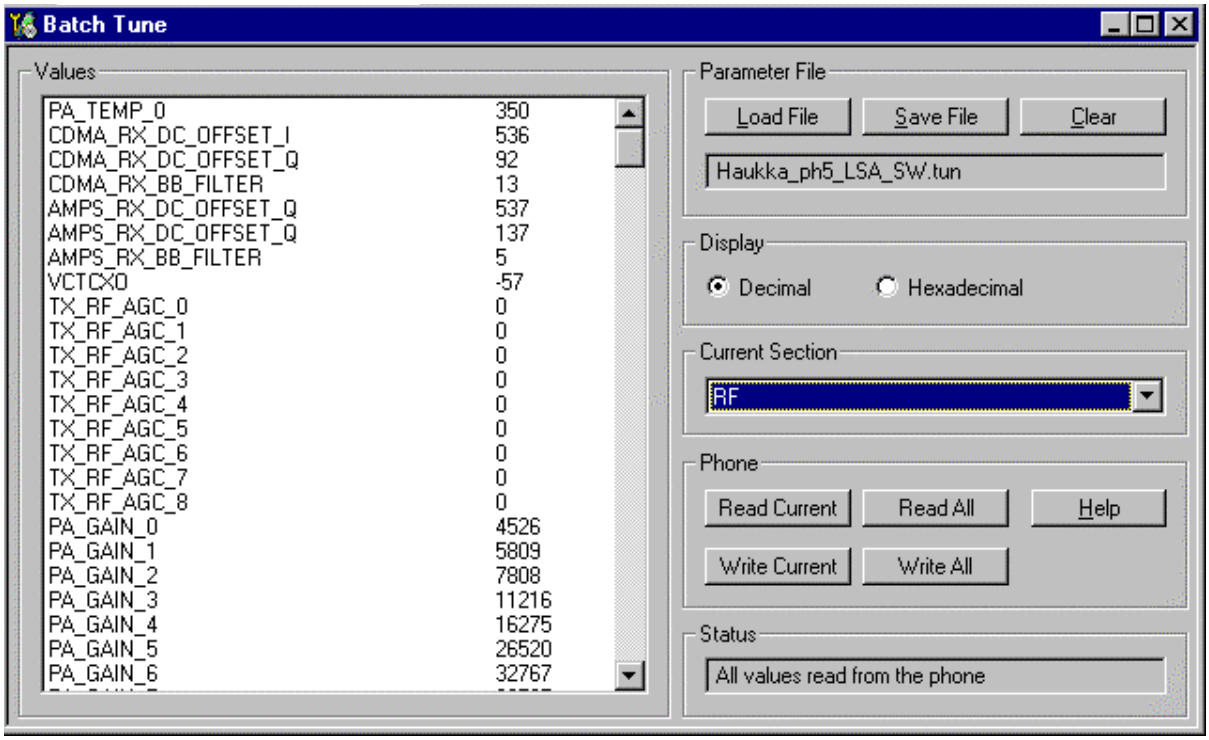
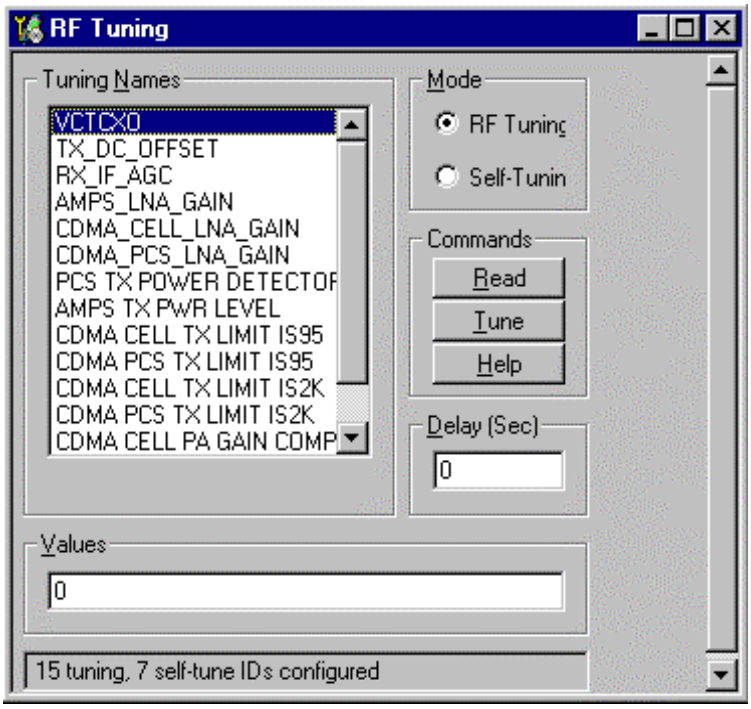
RF Tuning Parameters in Phoenix

⑧ Batch Tune in RF



⑨ RF Tuning in RF



Note:
When reading the tuning parameters from the phone, always use the "Read All" button in order to read the entire set of tuning values.

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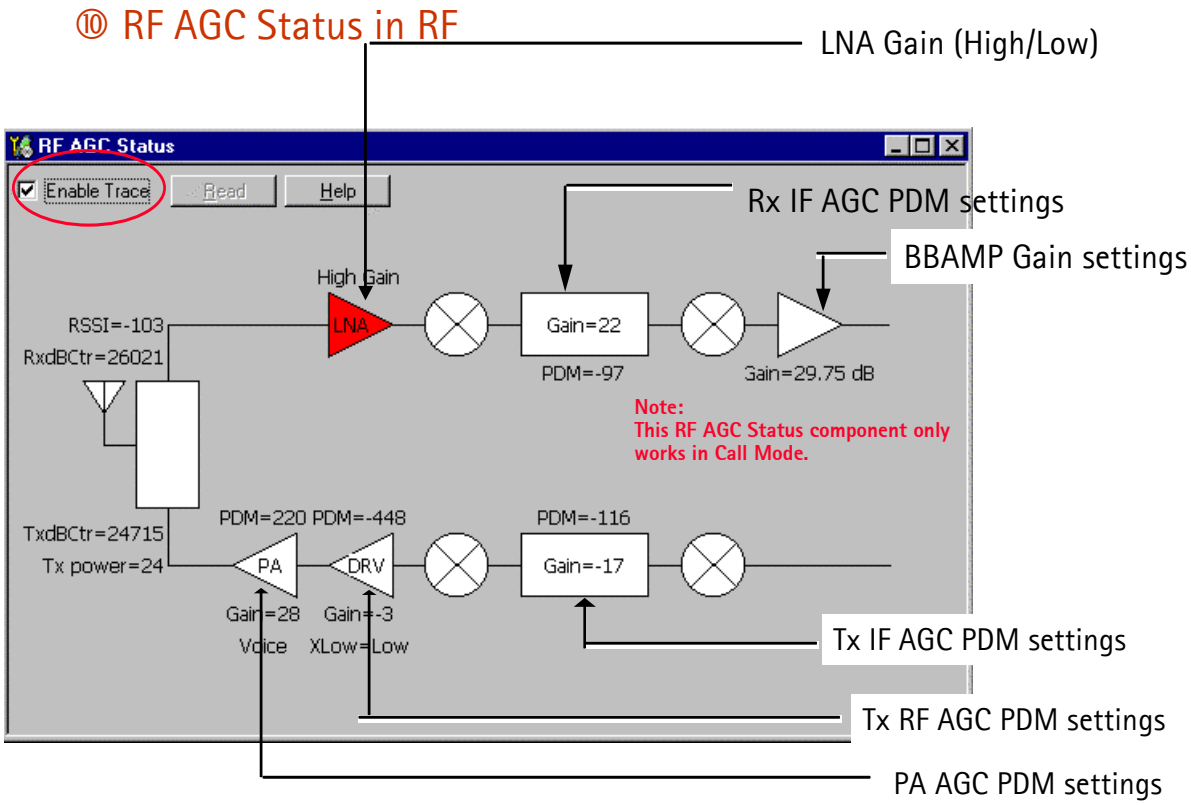
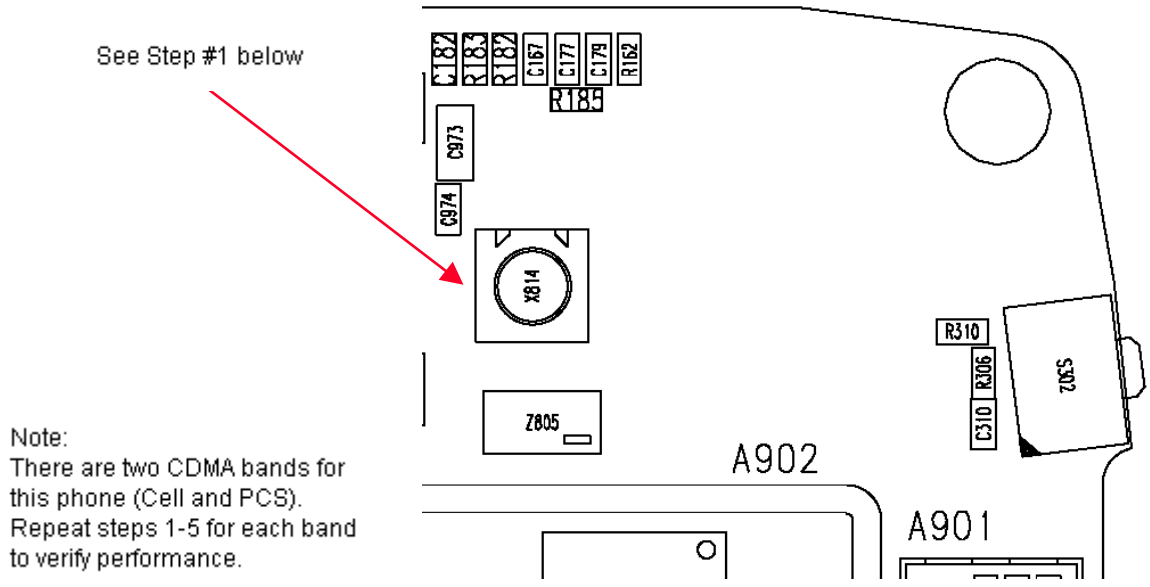
RF AGC Status Components in Phoenix



NOTE: Always measure resistance with the phone powered OFF.

CDMA In-Call Testing



1 Connect phone to call box via RF port (X814). (Add RF cable loss on call box ≅0.2 dB Cell band, ≅0.4dB PCS).

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2 Power up phone in "Normal" mode.

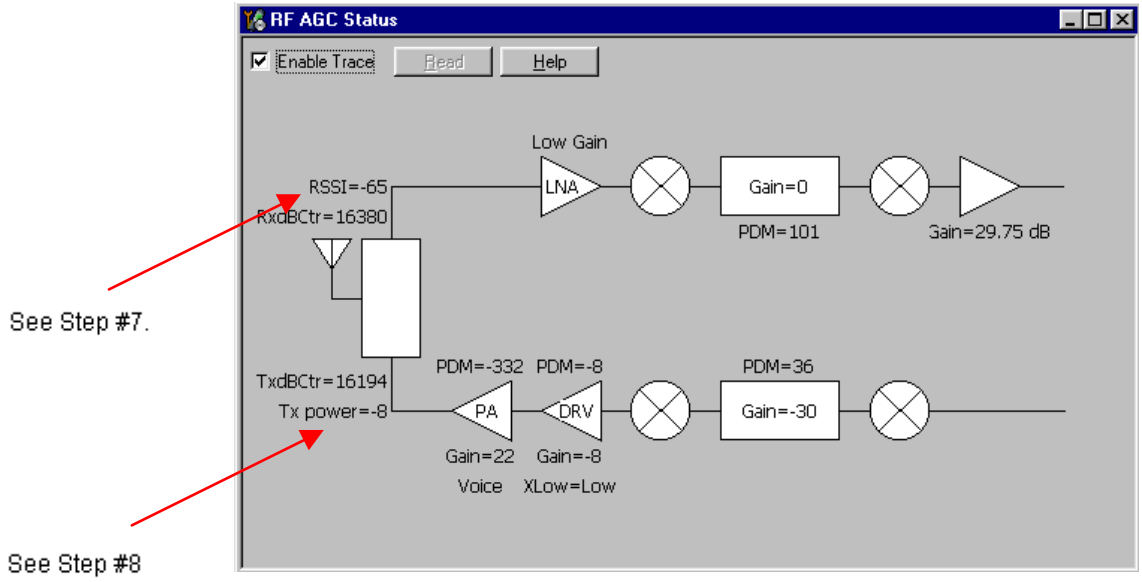
3 If necessary, to load CDMA PRL, first put phone into "Local" mode. Load PRL; set phone back to "Normal" mode. Make sure to set RF channel and SID according to PRL.

4 Register phone and establish call at –65dBm Call box sector power.

- If you cannot register phone, set sector power to –25dBm and try again.
- If a call cannot be made in either PCS or Cell band, then proceed with Local Mode troubleshooting. (See Note in above diagram.)

5 If the phone call is successful, open the "AGC Status" under RF menu. Click "Enable Trace" on the top left corner of AGC Status window.

CDMA In Call Testing (Low Gain)



AGC Tolerances

Band	Rx AGC	IF AGC	RF AGC	PA AGC
Cell CDMA	>40	<40	125+-30	<-300
PCS CDMA	>40	<40	120+-30	<-300

6 In a phone call, handoff to center channel (Ch. 600 for PCS, or Ch. 384 for Cell), and verify that call box sector power is –65dBm; the LNA will be in Low Gain.

7 Compare RSSI reading from "RF AGC Status" to the sector power. Compare TX Power to digital average power on call box. Should be +/- 2dBm accuracy.

8 Verify that cell PDMs for RX and TX and within tolerances specified above.

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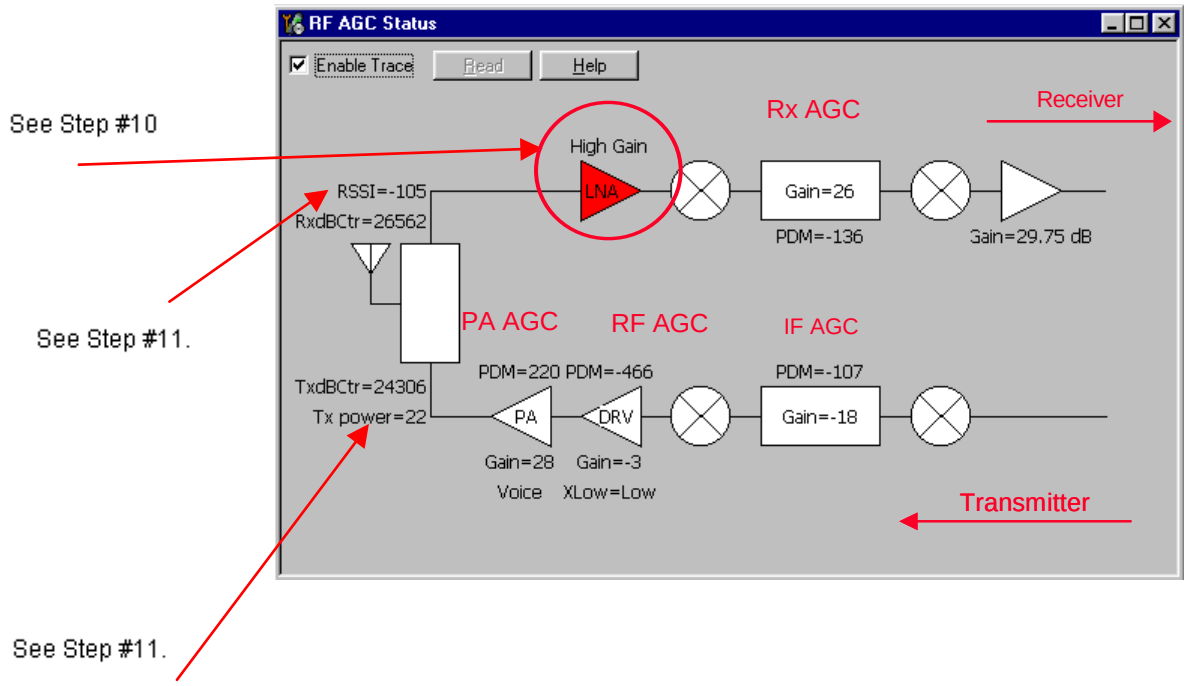
Cell: Tx pwr (dBm) = -73 – RSSI

PCS: Tx pwr (dBm) = -76 – RSSI

CDMA In Call Testing (High Gain)



AGC Tolerances for -105dBm INPUT

Band	Rx AGC	IF AGC	RF AGC	PA AGC
Cell CDMA	>-150	-115+-15	<-400	=220
PCS CDMA	>-150	-100+-20	<-400	=220

9 If Steps 6-9 are OK, then adjust the call box sector power to -105dBm. This will turn the LNA to High Gain.

10 Compare RSSI reading with the sector power on call box. Should be +/- 2dB accuracy.

11 Compare Tx power to digital average power on call box.

12 Verify that all PDMs for Rx and Tx are within tolerances specified in the above table.

Cell: Tx pwr (dBm) = -73 – RSSI

PCS: Tx pwr (dBm) = -76 – RSSI

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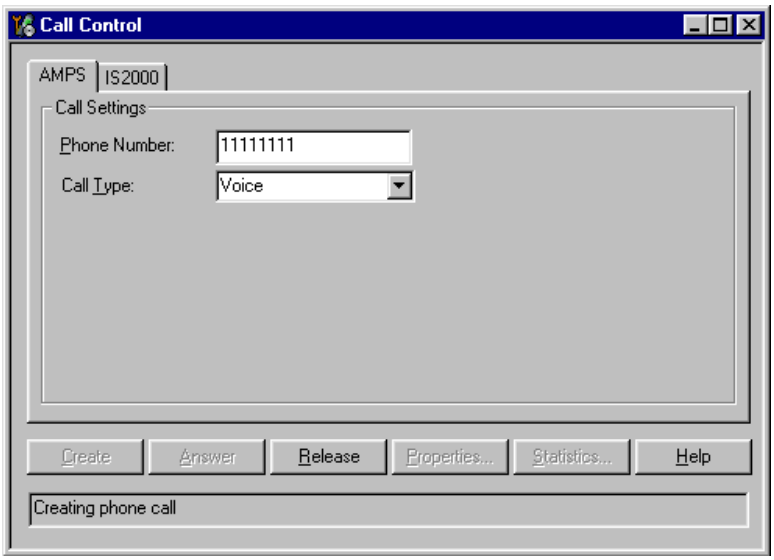
CDMA In Call Testing (AMPS)



1 Connect Phone to call box via RF port (X814). (Add cable loss on call box ≅0.2dB band.)

2 Power up phone in "Normal" mode.

3 If necessary, to load AMPS PRL, put phone into "Local" mode first, load PRL, then set phone back to "Normal" mode. Make sure to set Call Box control channel and SID.

4 Use "Call Control" under DSP menu. Add 8-digit phone number and create AMPS call.

If a call cannot be made, proceed with Local Mode troubleshooting.

5 Hand off to Channel 384 and PL2, and sector power -65dBm.

6 Compare RSSI reading from "RF AGC Status" to the sector power; should be +/-2dB accuracy.

7 Compare Tx power to digital average power on call box; should be +/-2dBm accuracy.

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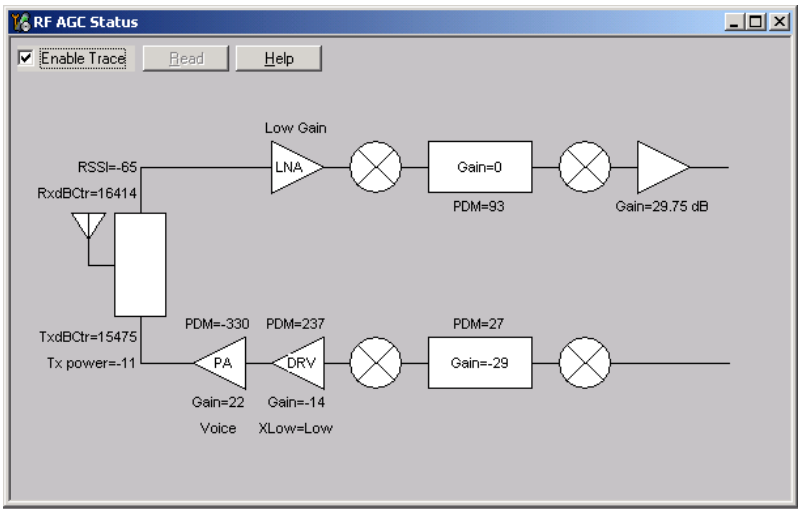
Summary of Typical Cell Band PDM Readings



Typical PDM Values

RSSI = -65dBm
LNA = Low Gain State
Rx IF AGC PDM = +93
Tx IF AGC PDM = +27
Tx RF AGC PDM = +237
Tx PA Gain PDM = -330
Tx Power = -11dBm

-65dBm Sector Power CDMA CH600

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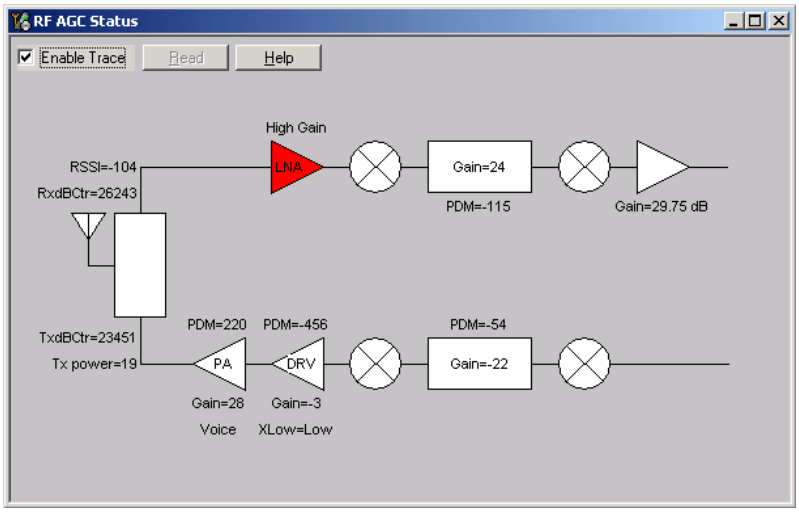

Typical PDM Values

RSSI = -104dBm
LNA = High Gain State
Rx IF AGC PDM = -115
Tx IF AGC PDM = -54
Tx RF AGC PDM = -456
Tx PA Gain PDM = +220
Tx Power = +19dBm

-104dBm Sector Power CDMA CH600

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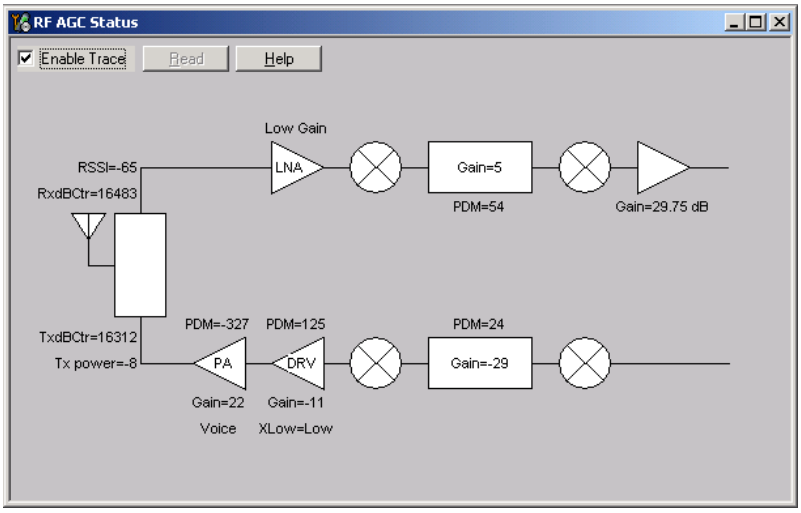
Summary of Typical PCS Band PDM Readings



Typical PDM Values

RSSI = -65dBm
LNA = Low Gain State
Rx IF AGC PDM = +54
Tx IF AGC PDM = +24
Tx RF AGC PDM = +125
Tx PA Gain PDM = -327
Tx Power = -8dBm

-65dBm Sector Power CDMA CH384

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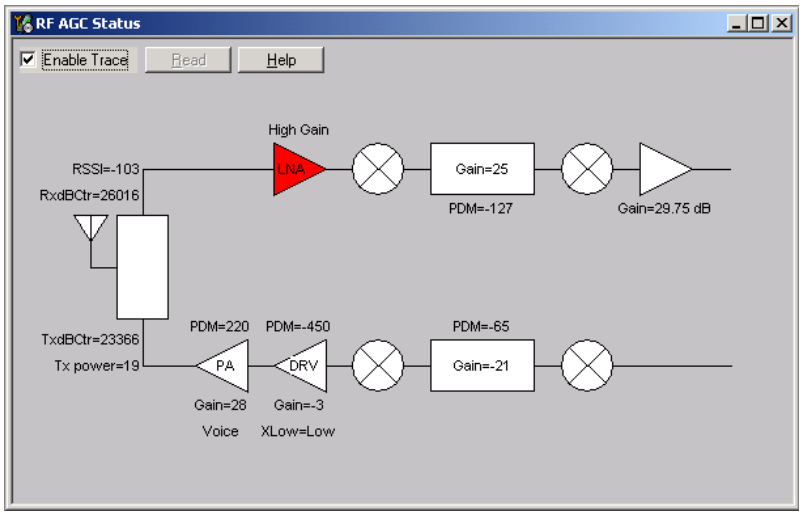
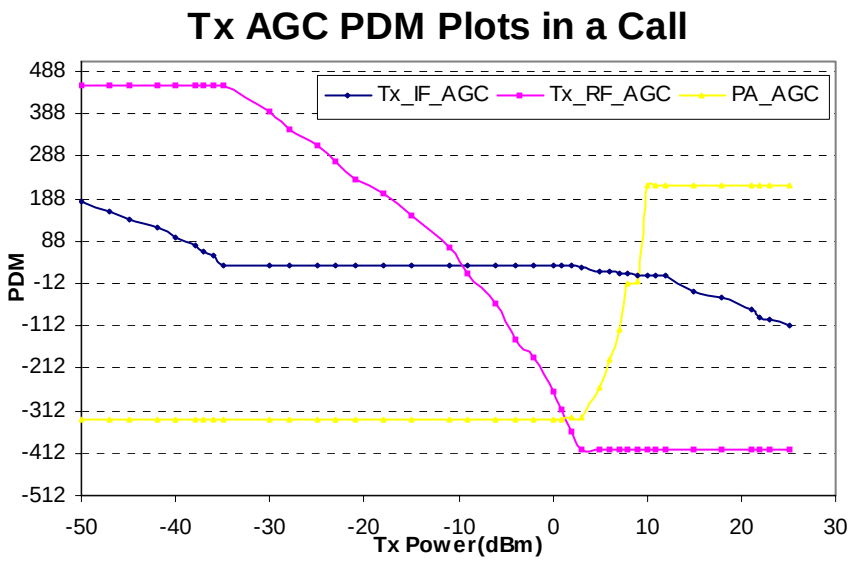


Typical PDM Values

-104dBm Sector Power CDMA CH384

RSSI = -103dBm
LNA = High Gain State
Rx IF AGC PDM = -127
Tx IF AGC PDM = -85
Tx RF AGC PDM = -450
Tx PA Gain PDM = +220
Tx Power = +19dBm

Tx PDM Characteristic Curves (Phone Call Mode)



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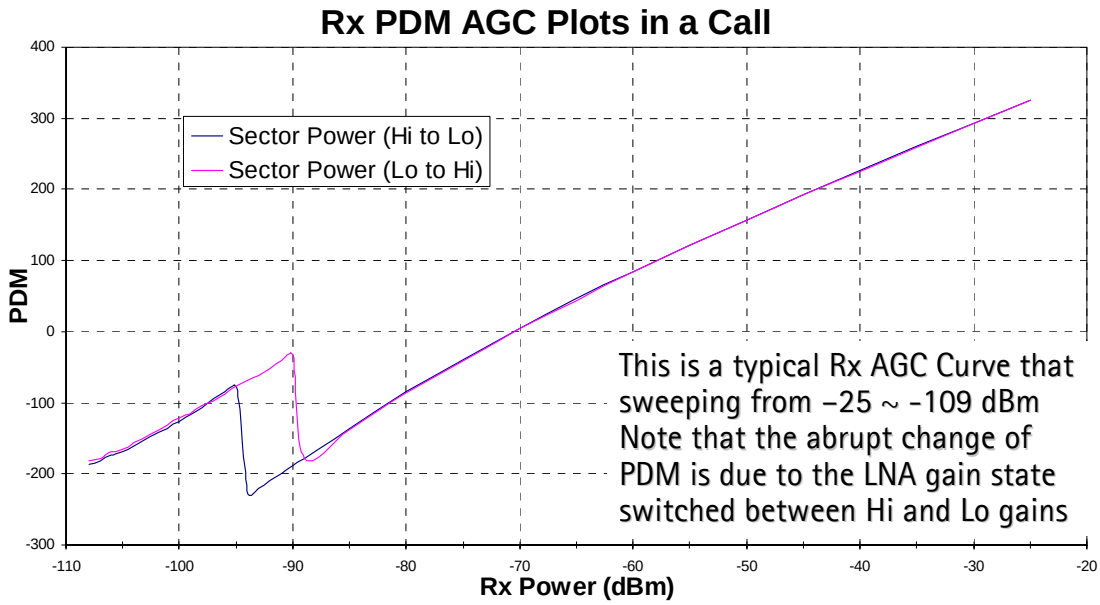
Rx PDM Characteristic Curve (Phone Call Mode)


Rx PDM AGC Plots in a Call
Sector Power (Hi to Lo)
Sector Power (Lo to Hi)
PDM
Rx Power (dBm)
This is a typical Rx AGC Curve that sweeping from –25 ~ -109 dBm
Note that the abrupt change of PDM is due to the LNA gain state switched between Hi and Lo gains

Key RF Performance Tests in Call Mode

Tx Tests

Max Limiting Power

Set the sector power to -95dBm or lower and set the Reverse Power control bits in the 8960 to *always up*. This is the maximum limiting power that the phone can provide. Check phone's limiting power vs. channels and see whether they are accurate to the limits. (Be sure to account for cable loss.)

Waveform Quality (rho)

This can be measured on the 8960 call box. Always measure at maximum power; should be greater than 0.97. The frequency error should be within +/-150Hz.

Spurious Emissions (ACPR)

ACPR can be measured on the 8960 call box. Always measure at maximum power. Limits for +/-885kHz and 1.98MHz are lower than at least -42dBc and -54dBc.

Rx Tests

Rx Sensitivity

Measure this on the 8960 call box. Always measure at max power. Rx sensitivity is defined as minimum sector power for 0.5% FER. Usually the result is better than -107dBm. (Be sure to account for cable loss.)

Receive Signal Strength Indicator (RSSI)

When in a call, you can verify the receiver received level by using the Phoenix RF AGC component. The RSSI reading should track with the call box sector power reading within

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2dB. Vary the sector power from -25dBm to -104dBm for accuracy. If the RSSI reading is off (e.g., 20dB), start the Local Mode troubleshooting.

LNA Switching (High/Low Gain State)

When in a call, you can verify at what point the LNA is turned ON (High Gain State) by using the Phoenix RF AGC component. The indicator for the LNA will turn red when it is turned ON. Usually, the LNA turns ON in between -93dBm and -95dBm. If the LNA does not turn off at all in the RF AGC window while in a phone call, you will have bad sensitivity.

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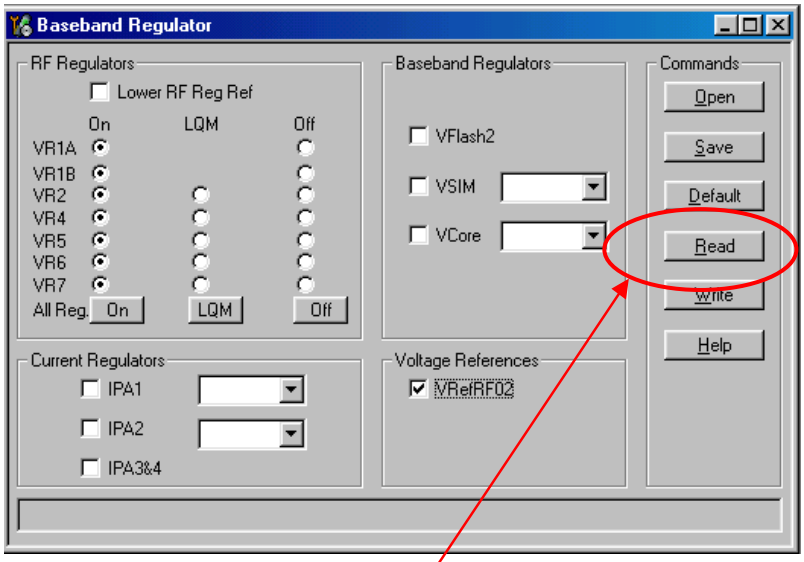
Supply Lines Measurement Using Phoenix

Baseband Regulator component

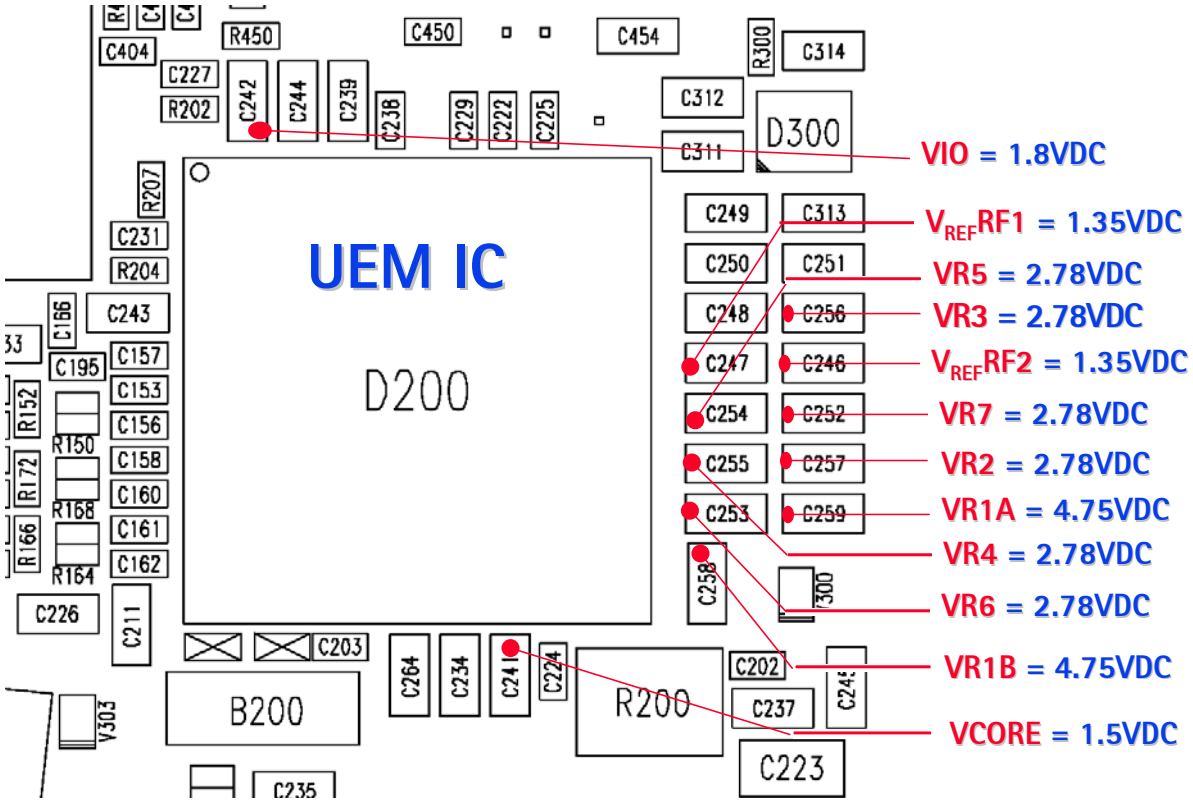


There are 12 RF-related regulators

1. VR1A
2. VR1B
3. VR2
4. VR3
5. VR4
6. VR5
7. VR6
8. VR7
9. VrefRF1
10. VrefRF2
11. VIO
12. VCORE

Before writing to phone, read the RF Regulators from phone to determine current state.

12 RF-related Supply Lines Distribution



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Supply Lines Distribution by RF Components

Alfred	N705	VR5
Batman	N701	VR5, VR7, VIO, V_{REF}RF1
Robin	N601	VR2, VR3, VR6, VIO, VR1B, V_{REF}RF2
Tomcat	N603	VBAT
PA	N801	VR2, VBAT
PA Detector	N806	VR2
VCTCXO	G501	VR3, VR1A
UHF PLL	N507	VIO, VR1A
VCO	G502	VR4
VCO Buffer	N502	VR6

12 Supply Lines Resistance to Ground

VR1A	100kΩ to GND	Synthesizer (VCTCXO, UHF PLL)
VR1B	29kΩ to GND	Robin
VR2	4.4kΩ to GND	Robin, PA, PA Detector
VR3	4.5kΩ go GND	Robin, VCTCXO
VR4	4.7kΩ to GND	VCO
VR5	3.2~5.1Ω to GND	Alfred
VR6	39kΩ to GND	Robin, VCO Buffer
VR7	38kΩ to GND	Batman
VIO	15kΩ to GND	Batman, Robin, UHF PLL
V_{REF}RF1	45kΩ to GND	Batman
V_{REF}RF2	46kΩ to GND	Robin
VCORE	4.5kΩ to GND	UEM, UPP

NOTE: Always measure resistance with the phone powered OFF.

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Top RF-related Failures Seen in FLALI

Test Failed	What to Check
RF EX Self-test Batman VHF PLL	Perform Local Mode testing of Rx VHF PLL on Batman (N501). Check that voltage levels at VR5 and VR7 are 2.7V. Also, check UHF LO level into Alfred (N750).
RF EX Self-test Robin VHF PLL CELL	Perform Local Mode testing of the Tx VHF PLL on Robin (N601). Check DC voltage (VIO, VR2, VR3, VR6). Probe Tx chain in Local Mode.
RF MS TX Start-up Amplitude	Check status of soldering on the balun presence of UHF LO. Check gain of PA and driver amplifier. Driver should have 12-16dB gain and PA should have 24-28dB gain.
RFTN VCTCXO Frequency	Measure VR3, VR1A voltage and probe for 19.2MHz output of VCTCXO. Next, check if Tx VHF PLL is on frequency. If previous tests are good, probe Tx chain in Local Mode.
RF TN TX IF AGC CELL or PCS Po(X) RF TN TX PA AGC CELL or PCS Po(X) RF TN TX RF AGC CELL or PCS Po(X)	Visually check soldering of the Robin (x-ray), supporting components, and PA. Also check D400, which generates the PDM signals. Troubleshoot the rest of the TX chain in Local Mode.
RF TN TX LIM Po IS95 CELL or PCS XX	If the max TX power cannot be reached, either a component in the transmitter has too much loss or not enough gain. Troubleshoot the corresponding Cell or PCS transmitter in Local Mode.
RF TN TX DC Offset CS	If the parameter fails, check version of FLALI software to ensure that it is the latest. Also verify that the tuning limits are correct.
RF MS RX IF AGC RXdbCtr(X)	Inject signal and probe Rx chain for gain to key out any failed parts.
RF MS LNA AMPS LowGain RF MS LNA AMPS HighGain	Inject signal and probe Rx AMPS chain for gain to key out any failed parts.
RF MS LNA CELL LO LowGain RF MS LNA CELL LM LowGain	Inject signal and probe Rx Cell chain for gain to key out any failed parts.
RF MS LNA PCS xx LowGain	Inject signal and probe Rx PCS chain for gain to key out any failed parts.
GPS MS Test Mode x (all tests)	Check VL_{NA_GPS}, V_{CORE}, V_{IO}. RF Probe GPS chain.

Top RF-related Failures Seen in FINUI

Test Failed	What to Check
RF MS TX Rho PCS CH600	Rho problem is very likely caused by elevated spurious levels in UHF LO and/or by VHF Tx LO in Robin. Establish a call and verify the degraded Rho. Next probe the LO output for spurs.

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Test Failed	What to Check
RF MS RX FER PCS CH600	At this stage, FER is most likely caused by a poor RF connection. Perform a conductive RSSI measurement with sector power at -65dBm (low LNA gain) and -100dBm (high LNA gain).
RF MS RX FER CELL CH384	At this stage, FER is most likely caused by a poor RF connection. Perform a conductive RSSI measurement with sector power at -65dBm (low LNA gain) and -100dBm (high LNA gain).
RF MS SINAD	SINAD is measurement of a phone's audio quality in an AMPS call. Hence, a secured audio plug is needed to be checked for any connection problem. Verify this on the bench in an AMPS call.
RF GPS Test Mode 3	Inject signal and test SNR with the GPS self-test. If SNR is out-of-limits, then probe chain.
RF MS TX Limiting Po PCS CH25	Tx limiting power is most likely caused by a poor RF connection.
RF MS TX Limiting Po CELL CH1013	Tx limiting power is most likely caused by a poor RF connection.

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